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ABSTRACT

The stability of teaching behavior was examined by observing student/teacher interaction over one academic year. One teacher was studied using a time-series analysis. He had 14 years experience and taught physical education in grades K-6 in a single school. Data were collected over one academic year using the Cheffers Adaptation of Flanders Interaction Analysis System (CAFIAS). A total of 52 classes were observed at equally spaced teme intervals throughout the year. Reliability of the data was confirmed using both intra- and interobserver reliability estimates. The 20 CAFIAS categories served as dependent variables and were subjected to univariate Box-Jenkins time-series analyses to determine stationarity. Autocorrelation functions indicated that five of the 20 CAFIAS categories demonstrated significant stationarity: teacher directions (verbal); student initiated responses (verbal and nonverbal); silence; and confusion. These five variables accounted for 28.5% of the total student/teacher interaction. Finding less than 30% of the behavior stable over a year's time led to the conclusion that the teaching behavior observed in this study may lack the stability necessary for making the inferential generalizations common to research conducted under the natural science paradigm. (Author/GDC)

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A Time-Series Analysis of Student and Teacher Interaction

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Running Head: Time-Series Analysis

A Time-Series Analysis of Student and Teacher Interaction

Abstract

Researching teaching using a natural science paradigm takes as given that teaching behavior is temporally located and stable. The assumption of stability allows the researcher to attribute change in behavior to experimental intervention and to believe that the change is both permanent and predictable. The purpose of this study was to assess the stability of the student/teacher interaction over one academic year. The design of this study was a single-subject, time-series analysis. The studied teacher had 14 years experience and taught physical education in grades K-6 in a single school. Data were collected over one academic year (September-May) using the Cheffers Adaptation of Flanders Interaction Analysis System (CAFIAS) (Cheffers, Mancini, & Martinek, 1980). A total of 52 classes were observed at equally spaced time intervals throughout the year. Reliability of the data was determined using both intra- and interobserver reliability estimates ($p < .05$). The 20 CAFIAS categories served as dependent variables and were subjected to univariate Box-Jenkins time-series analyses to determine stationarity. Autocorrelation functions indicated only 5 of the 20 CAFIAS categories demonstrated significant ($p < .01$) stationarity. The 5 categories were teacher directions (verbal), student initiated responses (verbal and nonverbal), silence and confusion. These 5 variables combined accounted for 28.5% of the total student/teacher interaction. Finding less than 30% of the behavior

stable over a year's time led to the conclusion that the teaching behavior observed in this study may lack the stability necessary for making the inferential generalizations common to research conducted under the natural science paradigm.

A Time-Series Analysis of Student and Teacher Interaction

The natural science research model has been regarded as a productive avenue in gaining knowledge relative to the phenomenon of teaching (Schempp, 1984). A basic tenet of the natural science paradigm when applied to teaching research is behavioral stability. For the purpose of this study, behavioral stability was defined as detectable behavior patterns having sufficient consistency of occurrence to allow for meaningful predictability. The assumption and/or determination of stability allows for three key components of the research process to be operational. First, behavioral stability allows researchers to detect trends in the observable actions of classroom life. Secondly, behavioral stability makes it possible for researchers to attribute detected changes to the experimental intervention. Causal relationships cannot be established with randomly occurring behavior. Thirdly, behavioral stability allows for the assumption that detected trends or changes are relatively permanent and predictable, thus permitting generalizations from the research findings.

Stability is also implied in the teaching process, that is the teachers hope their endeavors are linked to the past experiences of the students, hold present relevance and will have a meaningful influence on their students' future activities. In teaching research, the researcher assumes the events studied today also have a temporal reality, that is the behavioral events are linked to a meaningful past and may be used to predict or infer some future reality. Behavioral stability can thus be seen as a critical assumption in the undertaking and utility of research on teaching.

The question thus arises which researchers must address: Is the behavior of the students and teachers stable? Three previous studies have directly attempted to address this issue. After studying the interactional behavior of four elementary educators, Lombardo and Cheffers (1983) concluded that "teaching behavior and interaction are very stable" (p. 43). On the other hand, Rink's (1983) study of content development by three middle school educators indicated some behavior was stable and other behavior was unstable. Gusthart (1985), in a study very similar to Rink's, found the majority of a teacher's behavior unstable over 10 consecutive classes.

Behavioral stability appears a key component in understanding the fundamental nature of teaching. Yet, few research efforts have addressed this issue; and those that have lack congruence in methodologies, analyses and conclusions. The need still exists for an extended study of teaching. Therefore, this study was undertaken to determine the behavioral stability of student and teacher interaction over one academic year.

Methods

Design

Teaching in this study was conceptualized as a temporally related series of interactional behaviors between a teacher and students. This conceptualization appeared consistent with the behavioral intentions assumed in the teaching enterprise, (i.e. systematic and progressive learning by students) each class session thus represented a point along that series of interactions. The purpose of this study was to determine if teaching represented a stable series of observable events in education. An appropriate method of

determining the nature of a sequence of time-ordered observations is time-series analysis (Nurius, 1983). Time-series analysis generally requires at least 50 observations for a valid analysis (Dinitto, 1983). Therefore this study was designed to analyze the interactional behavior of at least 50 temporally located classes. These data points were collected over one academic year (September-May) to be consistent with the time frame of the school and to provide an extended picture of the student/teacher interaction.

The large number of observations required and the univariate nature of the analyses necessitated the use of a single subject. The limits of single subject research in social science are well known and therefore the lack of generalizability and the need to replicate this investigation were recognized from the onset. However, the need for this study and its potential as a demonstration for time-series methodology appeared greater than its design limitations.

Subject

The subject was a male elementary physical education teacher. This teacher possessed 14 years teaching experience and was teaching physical education for grades K-6 in a single school at the time of this study. He held both a bachelor of science and master's of arts degree in physical education. In general, this teacher appeared highly respected for his abilities and competence as a teacher by both his colleagues and students. Informed consent was obtained prior to data collection. The school was located in a suburban, midwestern university community.

Instrumentation

Observations were made using Cheffers Adaptation of Flanders Interaction Analysis System (CAFIAS) (Cheffers, et al., 1980). CAFIAS is an instument designed to record the verbal and nonverbal interaction of teachers and students. This instrument was believed appropriate because a.) it held demonstrated reliability and validity (Cheffers, et al., 1980), and b.) was able to account for the important nonverval (i.e. physical) component of the observed classes. The 20 CAFIAS behavior categories served as the dependent variables of this investigation.

Reliability of the CAFIAS data was determined using inter- and intra-observer reliability estimates. Interobserver observer agreement was determined by comparing the codings of the investigator and a qualified, neutral second coder. The investigator coded a videotape of the subject teacher and then mailed the tape to the second coder. The second coder was given no information regarding the study, but asked simply to code the tape for the purposes of a reliability check. Intraobserver reliability was determined by having the investigator code a second videotape twice, with a two-week time lapse between codings. All reliability data were collected from videotape observations, all time-series data were collected by the author from live observations.

Procedures

Data were collected via systematic observation of the subject teacher over one academic year (September-May). Observations were made at regulated time intervals using the following criteria: no more than one observation was made on any given day and no more than five school days lapsed between observations. Days in which the teacher was absent or days classes were

cancelled were not counted as school days. Each observation was equivalent to one class period. The class periods ranged in time from 25 minutes to 45 minutes. This protocol yielded 52 observations appropriate for analysis. The observations were chosen at random within the restrictions imposed by the school schedule and the schedule of the investigator. The observations represented at least two intact classes from each grade level ranging from kindergarten through sixth. Every grade level was observed a minimum of six times in an effort to control for grade level bias.

Two videotapes were required for the purpose of determining instrument reliability. Taping days were chosen at random and fell approximately two months apart. The need for the investigator to operate and monitor the appropriate machinery precluded data collection on those days.

Results

Reliability

CAFIAS data are analyzed in a matrix so that the interaction of the behavior categories may be determined. Coder reliability is then best estimated by comparing the matrices constructed from the multiple observations of the same class. Reliability estimates were calculated by rank ordering the matrix cells of the observations. The rank orders were then used to compute Spearman rank order correlation coefficients. Both the interobserver ($r = 0.78$) and intraobserver ($r = 0.77$) reliability estimates were found to be significant ($p < .05$). The investigator believed these estimates to be sufficiently high to conclude the data gathered for this study were reliable for the purposes of interpretation.

Descriptive Data

Table 1 provides mean scores and standard deviations for the 20 CAFIAS categories from the 52 observed classes. When the verbal and nonverbal categories were combined, the emergence of giving information (20.92%) and directions (9.14%) as the dominant teaching behaviors indicated this teacher engaged a fundamentally traditional teaching pattern. However, the frequent use of questions (6.35%) by the teacher and relatively high frequency of analytic (17.28%) and initiated (10.26%) responses on the part of the students demonstrated the presence of indirect teaching as well. The predominance of student rote responses (16.17%) and the insignificant occurrences of teacher praise (3.51%) and acceptance (4.1%) reaffirms the basically traditional posture of these classes. While the students' behavior (43.71%) and teacher's behavior (45.34%) were near equal, the primary mode of interaction for the teacher was verbal (38.2%) and the primary interaction medium for the students was nonverbal (32.25%) (i.e., teacher said, students did). The seemingly high rate of silence and confusion (10.94%) is indicative of the predictably high level of student to student interaction found in physical education classes. In the main, the studied teacher and students did not appear to exhibit interaction behavior different than what might have been anticipated based on previous research (Cheffers & Mancini, 1978).

Insert Table 1 about here

Time-Series Analyses

Data from the 52 observations were analyzed to determine behavioral stability. The 20 CAFIAS category percentages were subjected to univariate

Box-Jenkins time-series analyses (Hull & Nie, 1981). These analyses identified those variables with significant stationarity to be considered stable over the academic year. Relatively high autocorrelations appearing in the first few time lags which quickly decreased to near zero were indicative of stationarity within the data series. Autocorrelation functions resulting from this study's data revealed only five of the 20 CAFIAS categories as possibly demonstrating the stationarity necessary to generate accurate forecast models. Based on the initial analyses, the variables of teacher directions (verbal), student initiated responses (verbal and nonverbal), confusion and silence appeared stable (Table 2). Diagnostic chi-square statistics supported the initial findings, and therefore these five variables were determined stable (Table 3).

Insert Tables 2 and 3 about here

It should be noted that CAFIAS categories confusion and silence are used, in addition to their strict definitions, to distinguish student to student verbal (confusion) and nonverbal (silence) interaction. This double usage of these two categories is necessitated by CAFIAS being primarily a determinant of teacher/student interaction. A review of the interaction patterns embedded in the field observations revealed the consistent appearance of student to student interaction as accounting for the greater majority of the confusion and silence categories. The stability of the students' interaction is also consistent with the stability of the student-initiated responses; both verbal and nonverbal. If the students are interacting with one another, it appears

the majority of behavior defining that interaction must be student initiated. Although student-initiated interaction behavior was the only stable student behavior, it was the least frequently occurring (i.e., analytic responses = 17.28%, rote responses = 16.17% and initiated responses = 10.26% of all behavior over the academic year). The lack of frequency may, in part, account for its consistency, for there did not need to be much, if any, student to student interaction in each class to define a consistent trend. Therefore, although the student-initiated interaction was a stable behavior pattern, it did not appear a significant one.

In summary, the time-series analyses indicated teacher direction giving as the sole stable teacher behavior. The students' initiated behaviors, verbal and nonverbal, were the stable student behaviors. Finally, student to student interactions, both verbal (confusion category) and nonverbal (silence category), were stable. In total, 28.57% of all categorically observed behavior was demonstrably stable over the academic year.

Discussion

Finding only five behavior categories stable, which in turn accounted for less than 30% of the total behavior, led to the conclusion that the interaction between the studied teacher and his students lacked the stability to predict pedagogical practice over an academic year. These findings appear to support previous research on teaching stability. Although Rink (1983) and Gusthart (1985) used shorter time frames and a different observation instrument, they also found a general lack of stability in pedagogical behavior.

If teaching behavior lacks predictive temporal stability, the engagement of natural science models to investigate teaching must be undertaken with care and conclusions drawn from such research must be treated cautiously and conservatively. Phenomena studied under a natural science model must be temporally stable to allow findings to be predictive and generalizable. If teaching is not stable, natural science research findings may be either temporary occurrences or indicative of a researcher's ability to alter the natural state of the studied teaching.

Prior to any sweeping changes in the paradigms and methodologies used to study teaching, studies such as the present one need replication. The current study observed only one teacher in one given time period in one place using one method of observation. Clearly, a single teacher and a single observation instrument are not sufficient to provide conclusive evidence that all teaching behavior is unstable. However, this study, combined with previous research by Rink (1984) and Gusthart (1985), evidence a trend in the fundamental phenomena of teaching. This consistent finding of the instability of teaching calls for further investigation. If teaching defies temporal explanation, what does explain and give meaning to instruction and what methodologies are appropriate for understanding that behavior? The findings of this study offer an interesting challenge to the way teaching is often perceived, studied, and discussed.

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Table 1

Mean Scores and Standard Deviations

for the 20 CAFIAS Categories

CAFIAS Code	Categories Behavior	$\bar{X}$	S.D.
2	Verbal teacher praise	2.59	1.39
12	Nonverbal teacher praise	0.92	0.69
3	Verbal teacher acceptance	2.85	1.50
13	Nonverbal teacher acceptance	1.25	1.63
4	Verbal teacher question	6.16	2.65
14	Nonverbal teacher question	0.19	0.33
5	Verbal teacher information	17.95	8.02
15	Nonverbal teacher information	2.97	3.79
6	Verbal teacher directions	7.37	3.88
16	Nonverbal teacher directions	1.77	3.26
7	Verbal teacher criticism	1.28	1.05
17	Nonverbal teacher criticism	0.04	0.10
8	Verbal student rote response	2.53	1.32
18	Nonverbal student rote response	13.64	8.94
8/	Verbal student analytic response	3.11	2.80
18/	Nonverbal student analytic response	14.17	12.72
9	Verbal student initiated response	5.82	4.62
19	Nonverbal student initiated response	4.44	8.00
10	Confusion, noise	5.60	8.84
20	Silence	5.34	6.11

Total teacher verbal behavior = 38.20%
Total teacher nonverbal behavior = 7.14%
Total Teacher Behavior = 45.34%

Total student verbal behavior = 11.46%
Total student nonverbal behavior = 32.25%
Total Student Behavior = 43.71%

Table 2

Autocorrelation Functions for

CAFIAS Behavior Categories

CAFIAS Codes	Time-Series Lags 1	2	3	4	5	6	7	8	9	10
2	0.01	0.24	0.19	-0.02	0.12	-0.04	0.05	-0.24	0.08	-0.07
12	0.17	-0.14	-0.16	0.18	0.23	-0.05	0.00	-0.11	0.08	-0.03
3	0.19	0.03	-0.04	0.11	-0.12	-0.03	-0.09	-0.15	-0.09	-0.23
13	-0.06	0.12	0.04	-0.04	0.12	-0.10	0.00	-0.17	0.04	0.06
4	0.05	0.11	-0.24	-0.28	-0.141	0.01	-0.23	0.08	0.13	0.03
14	-0.06	0.04	-0.17	-0.12	-0.17	0.03	0.24	0.08	-0.05	-0.03
5	0.24	0.17	0.04	0.02	-0.14	-0.08	-0.04	-0.15	-0.06	-0.08
15	0.14	0.07	-0.12	0.11	0.10	0.13	-0.01	-0.05	-0.03	-0.08
6	0.47	0.48	0.45	0.34	0.29	0.30	0.13	0.07	0.02	0.03
16	0.16	-0.10	-0.02	-0.04	-0.02	-0.08	-0.05	0.02	0.05	-0.10
7	0.20	0.16	0.07	0.04	0.13	0.06	0.17	0.01	-0.04	0.05
17	-0.05	0.10	-0.01	0.01	0.02	-0.02	-0.05	0.16	-0.07	-0.02
8	0.06	-0.09	-0.06	0.02	-0.00	0.03	-0.07	-0.18	-0.02	-0.10
18	0.17	0.09	0.31	0.20	0.11	0.10	0.15	0.05	0.04	0.17
8/	-0.04	0.22	-0.11	0.02	-0.16	-0.05	0.02	-0.07	-0.01	-0.05
18/	0.20	0.00	0.05	0.19	0.31	0.10	0.06	-0.27	0.17	0.17
9	0.58	0.54	0.28	0.35	0.21	0.29	0.04	0.05	-0.21	-0.07
19	0.57	0.35	0.19	0.21	0.24	0.42	0.21	0.00	-0.12	-0.07
10	0.54	0.39	0.44	0.29	0.28	0.30	0.07	0.01	0.02	0.00
20	0.56	0.20	0.27	0.39	0.21	0.07	0.27	0.35	0.17	0.09

Table 3

Diagnostic Chi-Square Statistics for

Residual Time-Series Analyses

CAFIAS	Lags (df)				
Category	6(5)	12(11)	18(17)	24(23)	25(24)
Teacher directions	54.5[a]	56.9[a]	58.0[a]	61.1[a]	64.2[a]
Student initiated response (verbal)	54.6[a]	59.6[a]	62.0[a]	68.6[a]	73.9[a]
Student initiated response (nonverbal)	43.7[a]	48.8[a]	51.1[a]	56.0[a]	56.6[a]
Confusion	50.3[a]	50.7[a]	52.3[a]	58.7[a]	60.1[a]
Silence	35.3[a]	54.7[a]	56.7[a]	70.6[a]	72.7[a]

[a] = significance beyond 0.01 level.